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minutes moved slowly, but with a direct, well coördinated gait, then it partly recovered, and moved more briskly. Another smaller *Epeira*-like spider did not seem to suffer, except that its motions were slower, and on being touched, it would gather up its legs and feign death.

A species of *Julus* and of *Polydesmus*, on amputation of their antennæ, rather long stumps remaining, were at first somewhat discommoded and then seemed to walk well, but less rapidly than before.

It would be premature to draw any inferences from these experiments, but the impression is left on the mind that in removing the antennæ in some cases, it seemed as if something more was effected than making the insect deaf or depriving it of the sense of taste or smell, and it seemed as if the ganglionic centres were affected, particularly the supra-œsophageal pair, the insect being at first more or less stunned or confused, and then, in many cases, acting as if the nervous centres were permanently affected; not so much as if one of its senses, but all or nearly all, were more or less affected. In fact, the movements somewhat resembled those of a dove from which the cerebral hemispheres had been removed, as in the case described in Dalton's Physiology, and the fact that the insects can distinguish light from darkness, perhaps the main function of the eyes, and taste their appropriate food, does not militate against the idea that the nervous centres are seriously affected. On the other hand, no such effects are produced when the leg, or even, in some cases, the abdomen, is removed. I do not see that my experiments enable us to prove anything as to the nature of the function of the antennæ, except to indicate that the insect's brain is as it were projected into them, and that their nerves probably possess nucleated cells, homologous with those of the ganglia from which the sense-nerves originate.

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RECENT LITERATURE.

Ganin's Metamorphoses of Insects.[1] — The author begins with a rapid survey of previous investigations by Weismann, Uljanin, Chun, Paul Mayer, Auerbach, and shows the unsatisfactory condition of our knowledge and the necessity of a verification of the statements of those authors. "My own observations," says he, "embrace several Diptera (*Anthomyia*, *Sarcophaga*, *Musca domestica*, *Scatophaga*, *Eristalis*, *Stratiomyia*); several species of *Formica* and *Myrmica*; one Lepidopteron, *Lithocolletis*; and of Coleoptera, *Tenebrio* and *Chrysomela*. Among the Diptera, my fullest researches were those on *Anthomyia rufipes*, a smaller species being easier to handle in preparing cross-sections, especially in the pupa state, when most of the organs are destroyed. In *Sarcophaga carnaria*, I observed the structure and the development of imaginal discs, anterior to pupation. The relationship of this species, as well as of *Musca vomitoria*, studied by Weismann, to *Anthomyia* authorizes the assumption that whatever is explained here about the development of the latter genus is equally applicable to *Musca vomitoria* and *Sarcophaga carnaria*, and also to the other above-named *Muscidæ*."

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[1] *Materials for a Knowledge of the Post-Embryonal Development of Insects.* By Professor M. Ganin. Warsaw. 1876. 4to, 76 pages and 4 plates. (Extracted from the Transactions of the Fifth Meeting of Russian Naturalists in Warsaw; Section of Zoölogy and Comparative Anatomy.)

"More or less complete are my observations on the development of the teguments of the head, the thorax, and the abdomen, with their excrescences; also on the development of the alimentary canal. The aim of my studies was not so much to investigate the details of the development of this or that organ as to observe the mode of formation of the rudiments of organs, the material out of which they are developed, and the time of their appearance. Many facts, introduced into science by Weismann, — for instance, those which refer to the part played by the imaginal discs in the development of the imago, — must retain their scientific weight, with slight emendations, with respect to the development and structure of those discs; but another category of results, elicited by Weismann, — namely, those relating to the histolytic processes, the formation of the tissues of the imago from the produce of the destruction of the organs of the larva, — must be considered as erroneous and replaced by others." (Pages 4, 5.)

The main portion of the author's dissertation is divided into nine chapters, which embody his own observations, and are entitled, *Imaginal discs* (Muscidæ); *History of the development of the head; History of the development of the abdomen of the imago; Adipose body and destructive processes; Imaginal discs of the ant* (Myrmica); *History of the development of the leg of Lepidoptera and Coleoptera; History of the development of the alimentary canal* (Muscidæ); *History of the development of the proboscis; History of the development of the alimentary canal of Myrmica, Lithocolletis, and Tenebrio.*

It would be impossible fairly to render the contents of these chapters without translating the whole of them; it will suffice here to give a translation of the concluding chapter (page 64), which sums up the author's results and views. "*Conclusions.* In consequence of the above-stated facts, as well as of several still unfinished researches of mine concerning the development of the central nervous system and of the dorsal vessel, we may reach the conclusion that the formation of the organism of the imago, during the period of its post-embryonal development, is accompanied by the following processes : *Processes of destruction*, when organs or tissues of the larva are entirely or partially disintegrated. The products of this disintegration are not used immediately in the development of new histological elements, but are assimilated by suction and play the part of nutritive materials. *Processes of transformation*, I call those morphological processes, during which the formation of a new organ takes place without the participation of a newly formed morphological rudiment, but when the old organ, without being destroyed, passes into the morphologically corresponding organ of the imago, the newly appearing organ differing more or less, morphologically and histologically, from the old one. Thus the central nervous system of the larvæ of *Muscidæ* is not destroyed, but is transformed into the central nervous system of the imago, the latter differing very much, in its shape and structure, from the former: new parts have appeared; the first knot of the abdominal cord, not existing in the larva, is differentiated; the *ganglion opticum* is newly formed; the shape and structure of the abdominal cord are changed, etc. The histological elements of the tissues of the new organ are derived from those of the transforming larval organ. It is very probable that the dorsal vessel of the imago of *Muscidæ* is only transformed from the dorsal vessel of the larva. It seems to me that in the *Muscidæ* the dorsal vessel does not interrupt its functions during the period of post-embryonal development: very often the contractions of the dorsal vessel of *Anthomyia rufipes* were observed during the second and third day after pupation, when the greater part of the larval organs were already destroyed. The trifling differences between the dorsal vessel of the imago, as compared to that of the larva, may consist in its shape, the number, shape, and position of its wing-shaped muscles, the number and position of the venose openings, etc.

" *Processes of the formation of new organs.* The variety of these processes depends, of course, on the morphological and physiological conditions of the newly forming organ. These processes consist in the building up of an organ of the imago from a special morphological rudiment. Thus from the morphological rudiments called imaginal discs, are evolved entirely new parts of the body of the imago, with their different tissues — head, thorax with the extremities, muscles, nerves, etc.; portions of the cephalic discs are converted into the compound eyes of the imago; out of the thickening of the abdominal segments of the larva of *Anthomyia* is developed the musculature of the abdominal segments of the imago, etc. It must, however, be at the same time remembered that there are no well-marked boundaries between these different processes; the terms used are intended merely to designate the most marked phase of this or that process. The definitions given of those processes have only a relative meaning, like all our definitions in morphological science.

"Finally, it also happens that parts or organs of the larva, during the period of the post-embryonal development, will pass into the corresponding parts of the imago without any change, or with very little change. Thus, for instance, a part of the adipose body of the larvæ of the *Muscidæ* and of the ant pass into the adipose cells of the imago. It is worthy of notice that it is only after the last molt of the larva of *Corethra* that those large bundles of colossal adipose cells make their appearance, which surround the anterior tracheal bladders; but they pass without any change into the imago, without furnishing, directly or indirectly, any material for the formation of the organs of the imago. This fact, taken singly, does not weigh in favor of the importance of the adipose body as a living, plastic material for building up the organs of the imago in the period of the post-embryonal development. The so-called histolytic processes, in the sense of Weismann,[1] as well as the process of an independent formation of the cells from the products of the destruction of the larval organs, I have never observed.

"The comparative examination of all these processes, which take place in the period of the post-embryonal development of different insects, leads us to the conclusion that, from the number of the processes of new formation and destruction, as well as from their morphological meaning, the highest place in the series of all the insects must be granted to the *Muscidæ.* Besides the already known facts of comparative anatomy, may be adduced the data obtained through embryological researches, which confirm the above-mentioned statement. The position of the imaginal discs in the cavity of the body, the mode of development of the head, the chest, the proboscis with all its parts, the entire destruction of the exoderm of the first four segments of the larva, the entire destruction of all its abdominal muscles, etc., — all these circumstances lead to the conclusion that the organism of the *Muscidæ* has undergone more modification than that of any other insect, during its phylogenetic development. The mode of development of the strata of rudiments in the imaginal discs of the *Muscidæ,* as compared to that in the discs of other insects, serves to confirm that conclusion. In the larvæ of *Muscidæ,* both strata of rudiments of the disc are formed anew from a common cellulose germ on the peritoneal envelope of the tracheal tube, or on the neurilemma of the nerve. In *Corethra, Miastor,* and in the Hymenoptera, strictly speaking, the mesoderm of the disc is alone a new formation, developed with the participation of the nerve and the tracheal tube; the exoderm of the disc is derived from the epithelial

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[1] I say in the sense of Weismann because later observers, as C. Chun, P. Mayer, often use the term *histolyse* indifferently: often cases of ordinary destructive processes are called by them *histolyse.* Weismann, on the contrary, clearly distinguishes this second *histolytic* process from the three other processes of formation of the organs of the imago. The *histolyse,* according to Weismann, takes place only when the organ of the larva furnishes the skeleton to the organ of the imago, etc., etc.

cells of the thoracic segments of the larva. In butterflies and beetles, the part corresponding to the exoderm of the imaginal disc is derived from the epithelial sac of the leg of the larva; the mesoderm likewise is a new formation. It is very probable that a further inquiry into the processes of the post-embryonal development of other Diptera, and also of insects of other orders, principally of such groups as have so-called apodal larvæ, will disclose some transitional forms of post-embryonal processes leading towards the extreme and well-characterized type of development of the *Muscidæ.* Thus it is now well known that *Miastor*[1] is a connecting link between *Muscidæ* and *Tipulidæ*, as regards the history of the development of its head. The dorsal portion of the head of *Miastor* is developed from the cephalic discs, the position of which is similar to that of the cephalic discs of the *Muscidæ;* the ventral and lateral portions of the head of the imago of *Miastor* are developed with the participation of the teguments of the larval cephalic segment. The development of the organs of the mouth of *Miastor* is much nearer to that of *Corethra.*

"The musculature of the head of the larva of *Miastor*, according to Zalensky, passes without change into the muscles of the head of the imago. It is to be regretted that we do not find in the work of Zalensky any mention of destructive processes in the cephalic segment of the larva of *Miastor.* If the destruction of the exoderm of the cephalic segment of the larva is not recognized, at least in its dorsal region, it is difficult to understand how the newly formed part of the head can assume its normal relative position towards the old larval exoderm of the cephalic segment.

"Some morphological importance must also be attributed to the interesting fact, that in the larva of *Miastor*, the formation which is homologous to the pair of cephalic discs of the larvæ of *Muscidæ* appears in the shape of a single (not paired) organ, although judging by the nerves with which it is connected, it corresponds to the pair of cephalic discs of the *Muscidæ.*

"The principle adopted by Weismann for the division of all insects into two sharply defined types, according to their post-embryonal development, and which depends upon the presence or absence of histolytic processes, and also on the mode of formation of the histological elements of the tissues of the imago, — in one case from the *Körnchenkugeln*, in the other with the participation of the elements of the tissues of the larva, — after all that has been said above, must lose its scientific value. It seems to me that the principles which must guide us in the grouping of insects with regard to their post-embryonal development are the number and quality of the destructive processes, the different modes of the building up of the organs of the imago from the newly formed morphological rudiments, the number and the morphological importance of the organs transformed from the organs of the larva, and of those which pass, without change, into the organs of the imago.

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[1] Article by Mr. Zalensky, in the Proceedings of the Third Meeting of the Russian Naturalists in Kiew.

"I deem it proper to examine here the question of the morphological importance of the imaginal discs of insects in general. The data respecting their embryology and comparative anatomy render it very probable that the thoracic imaginal discs, hidden in the body of *Muscidæ*, the thoracic imaginal discs placed immediately on the skin of *Corethra*, *Miastor*, and the Hymenoptera, and the thoracic legs of the larvæ of Lepidoptera and Coleoptera, are homological formations, replacing each other in all those groups. In other words, and more explicitly, I believe that the thoracic imaginal discs of the Hymenoptera, *Muscidæ*, *Corethra*, and *Miastor* are nothing but reduced ambulatory legs, which in other insects (Lepidoptera and beetles) are used as organs of progression, but in the above-mentioned groups (*Muscidæ*, etc.), have lost their physiological value, and have preserved in the history of their development a mere record of that value. This view may be sustained by the following scientifically pregnant facts: (1.) All insects, the larvæ of which possess, in their thoracic segments, the so-called imaginal discs, do not have any rudiments of legs on the same segments during the period of their embryonal development; in other words, the imaginal discs take the place of the legs, which, in other insects, appear much earlier, in the same places, during the period of the embryonal development. (2.) In insects, the larvæ of which possess thoracic legs, these latter are transformed into the legs of the imago, in such a manner that the final segmentation of the joints of the leg of the imago appears more or less sudden and simultaneous, in consequence of the segmentation of the corresponding leg of the larva, which has been very much drawn out in length. On the contrary, those insects, the larvæ of which, instead of thoracic, ambulatory legs, have imaginal discs, show, before the appearance of the final segmentation of the leg of the imago, a stage of a *provisional* segmentation of the leg in the developing imago. Thus, the segments of the leg of the imago of *Muscidæ*, Hymenoptera, etc., do not all appear simultaneously, but gradually, first one, then two, three, etc. This provisional segmentation of the leg, growing out of the imaginal disc, must be considered, probably, as the expression of the ultimate segmentation of the leg which it formerly possessed; or, in other words, the provisional segments of the leg, developing from the imaginal disc, remind us of the permanent segments of the larval legs of Lepidoptera, beetles, etc., which, in these latter, are used as temporary, provisional, locomotive organs. (3.) I believe that great morphological importance must be attached to the fact that during the development of the imaginal disc of the *Muscidæ*, the Hymenoptera, *Corethra*, and *Miastor*, the provisional cavity in the disc, which has no ultimate meaning, appears first of all. The scientific meaning of this provisional cavity, as well as of its outward tegument, can be explained, I think, as follows: The fact that imaginal discs, formations homologous to ambulatory legs, are situated in the cavity of the larval body, in connection with the tracheæ and nerves, must undoubtedly be understood as a consequence of the compound process of the displacement of the imaginal disc from the surface towards the inner cavity along the tracheal tube or nerve. The larvæ of *Corethra*, *Miastor*, *Chironomus*, have the imaginal discs more on the surface of the skin than those of the ant (*Myrmica*). In the former larvæ, these formations are walled in by a comparatively less developed fold of the skin. In the larvæ of *Myrmica*, this deep fold is transformed into a well-developed bag, which, together with the leg of the imago, developing within it, is placed during a certain time within the cavity of the larval body, below its muscular, subcutaneous stratum. In these insects, after the leg is stretched outside, the bag enclosing it is atrophied, and has no ulterior meaning. If we represent to ourselves that the outside aperture, leading into the provisional bag, with the incipient leg of the ant, is closed, we obtain all the homological parts of the disc of an ant as compared to the disc of *Muscidæ* in the corresponding stage of development. That is, the part of the disc of the *Muscidæ* which I described as its outside tegument, becomes the homologue of the closed fold of the skin in the disc of the ant; the provisional cavity of the disc of *Muscidæ*, between its outer and inner tegument, is homologous to the cavity of the bag in the disc of the ant; the inner tegument of the disc of the *Muscidæ* and the thickening of the anterior half of the disc of the ant represent the beginnings of the leg of the imago, and are homologous formations. The phase of development of the imaginal disc of the ant, before it begins to project externally, when the extremity consists only of three provisional segments, and the corresponding phase in the disc of *Muscidæ*, entirely concealed within the cavity of the body, are remarkably alike anatomically, if we do not pay attention to the external opening in the disc of the ant. It seems very probable that, when the post-embryonal development of different insects is better investigated, embryological facts will be found, which will favor the view, explained above, of the imaginal disc of *Muscidæ* being comparable to the disc of the ant (*Myrmica*). I mean to say, that an intermediate stage of the imaginal disc will be found, during which it occupies in the full-grown larva a position similar to its position in the larvæ of *Muscidæ*, and has at the same time its outer integument and provisional cavity similar to those of the ant.

"The paired abdominal thickenings which appear on the sides of the abdominal segments in the larvæ of *Muscidæ* before the formation of the permanent abdominal segments of the imago are, I think, morphologically homologous with the thoracic imaginal discs, and may be called abdominal imaginal discs.

"The facts communicated by me concerning the formation of the alimentary canal of the imago during the post-embryonal development induce us, first of all, to reflect on the question, What transformation does the entoderm of insects which undergo the so-called complete metamorphosis pass through from the very beginning of the life of such insects? For the solution of the question how many times the entoderm of such insects is changed, science unfortunately does not as yet possess sufficient data concerning the development of the entoderm during their embryonal development.

"If the supposition of some investigators, who look upon the abdominal depression very early visible in the blastoderm of *Hydrophilus*, *Apis*, etc., as a stomach (*gastrula*), proves to be correct, and if, secondly, my observations are verified, that, notwithstanding the presence of this provisional entoderm (*gastrula*), the final epithelium of the median intestine of the embryo may develop anew with the help of the epithelium of the anterior and posterior intestine, then we will be able to affirm with assurance that the imago of insects with a complete metamorphosis has a *tertiary* entoderm. On the contrary, if it become established as a scientific fact, that the stomach (*gastrula*) of insects is transformed directly into the entoderm of the median intestine of the larval embryo, then the entoderm of the imago of the above-indicated insects should be called *secondary*. There is a considerable array of facts in favor of both of these suppositions, but in order to obtain a final solution of this important morphological question, we must wait for more numerous observations on the development of the entoderm during the embryonal and post-embryonal periods.[1]

"As to the anterior and posterior intestine, it seems very probable that these portions of the alimentary canal of the imago of insects which have a complete metamorphosis are *secondary* formations."

RECENT BOOKS AND PAMPHLETS. — On the Fishes of Northern Indiana. By D. S. Jordan. On the Genera of North American Fresh-Water Fishes. By David S. Jordan and Charles S. Gilbert. (From Proceedings of the Academy of Natural Sciences, Philadelphia.) 8vo, pp. 104.

Die Wanderheuschercke (Œdipoda migratoria Linn). Gemeinverständliche Darstellung ihrer Naturgeschichte, Lebensweise, Schädlichkeit, und der Mittel zu ihrer Vertilgung. Von Dr. A. Gerstäcker. Berlin. 1876. 8vo, pp. 67. Two colored plates.

Catalogue of the Lepidoptera of America North of Mexico. Part I. Diurnals. By William H. Edwards. Philadelphia, Pa. 1877. 8vo, pp. 68.

Antigeny, or Sexual Dimorphism in Butterflies. (From the Proceedings of the American Academy of Arts and Sciences, xii. 1877.) 8vo, pp. 8.

Bulletin of the United States Entomological Commission. No. 2. On the Natural History of the Rocky Mountain Locust, and on the Habits of the Young or Un-

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[1] Paul Mayer, in his Ontogeny and Phylogeny of Insects, speaks of the gastrula-stomach of the embryo of *Platygaster*, without noticing that this stomach is simply a fold of the body of the embryo, separating its cephalic and caudal haloes. The embryo of *Platygaster* is a highly convenient object for observation, and I can say with assurance that in this case the primary entoderm is not formed through the invagination of the exoderm.